History and Geomorphology of Big Creek, 1906 through 2002

Big Creek, a major tributary of Quinault River system, is located on the north side of the Quinault River valley. It enters the Quinault River between RK 7.5 and about RK 10 (Figure 1). Bedrock limits the west migration of lower Big Creek; the upstream section of Big Creek is incised into Pleistocene and Holocene surfaces (Figure 1). A section of Big Creek about 5 km upstream of the Quinault River is dry for much of the year as flow goes into the subsurface.

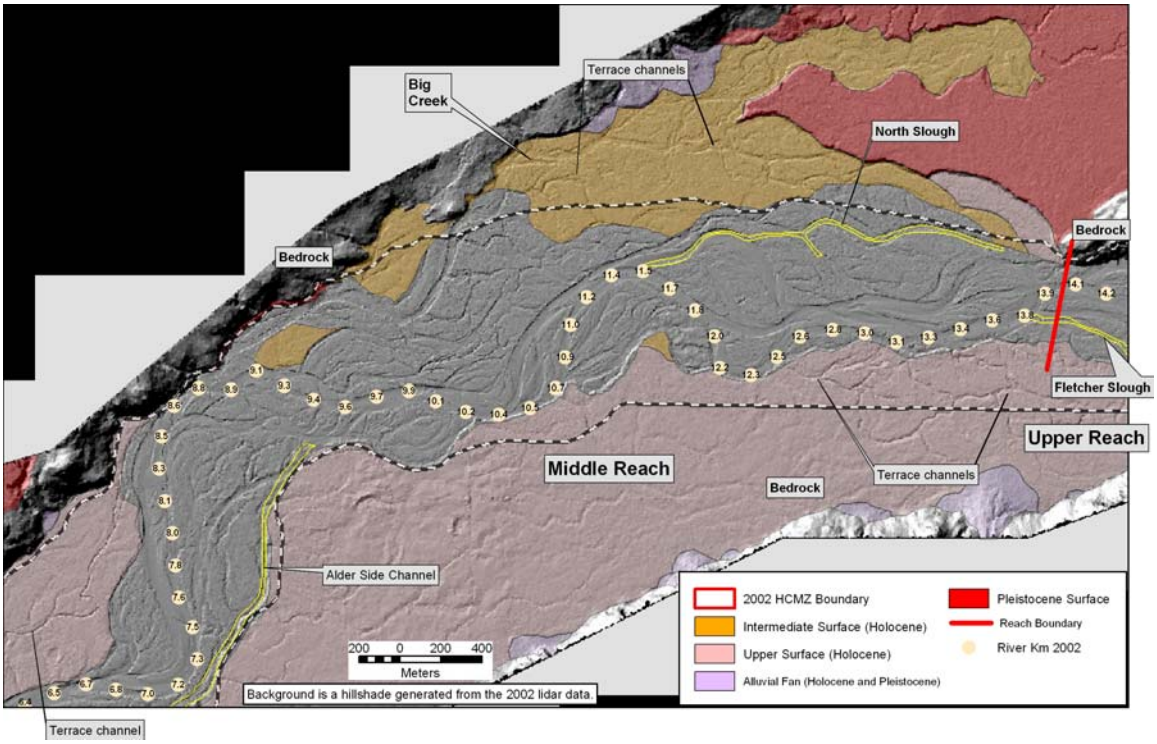


Figure 1. Big Creek is located on the north side of the Quinault River valley and enters the Quinault River between RK 7.5 and RK 10.

Lower Big Creek

The length of the section of lower Big Creek that could provide habitat has varied since 1906 (Figure 2). The active channel was at the upstream end of lower Big Creek in 1906 (at our HCMZ boundary), and the amount of potential habitat was probably limited at that time.

The length of potential habitat along lower Big Creek was estimated using the positions where Big Creek intersects 1) the active channel of the Quinault River and 2) the unvegetated channel of the Quinault River. An assumption was made that the more flow that lower Big Creek gets from the Quinault River, the poorer the conditions for sockeye habitat. Thus, the section of lower Big Creek upstream of the upstream-most intersection with the Quinault River is considered the best potential habitat in lower Big Creek. The upstream-most intersection of Big Creek with the Quinault River is usually the

unvegetated channel of the Quinault River, which likely carries flow only at higher discharges and may have minimal impact on habitat conditions in lower Big Creek. However, depending upon the amount of time and the size of the flows carried by the unvegetated channel, the potential habitat downstream of this intersection may be marginal.

Once Big Creek intersects the active channel of the Quinault River, it is assumed that habitat conditions degrade, even if Big Creek is still visible downstream of this point as a separate channel. Thus, the section of Big Creek between the HCMZ boundary and its intersection with the unvegetated channel of the Quinault River is considered the minimum length of potential habitat in lower Big Creek. Similarly, the section of Big Creek between the HCMZ boundary and its intersection with the active channel of the Quinault River is considered the maximum length of potential habitat in lower Big Creek. In some years, Big Creek intersects the active and unvegetated channels of the Quinault River at about the same location. In these years, the minimum and maximum lengths of potential habitat in lower Big Creek are the same.

The maximum length of potential habitat in lower Big Creek has varied between about 675 m in 1929 to about 3475 m in 1982 (fig. 3). The minimum length of potential habitat in lower Big Creek has varied between 675 m in 1939 to nearly 1900 m in 2002 (fig. 3). The minimum length might better reflect the lengths of relatively stable potential habitat, because it includes only the section of Big Creek upstream of its intersection with channels of the Quinault River. Although the maximum lengths of potential habitat in lower Big Creek have been highly variable, the minimum lengths of potential habitat in lower Big Creek as measured to the unvegetated channel of the Quinault River have been relatively consistent (between 675 and 868 m) until 1998. In 1998, 2001, and 2002, the minimum length of potential habitat in lower Big Creek increased to between 1770 and nearly 1900 m (fig. 3). This occurred because the Quinault River channel moved to the south, preceding a dramatic change in the position of the channel in the winter of 2002 and 2003.

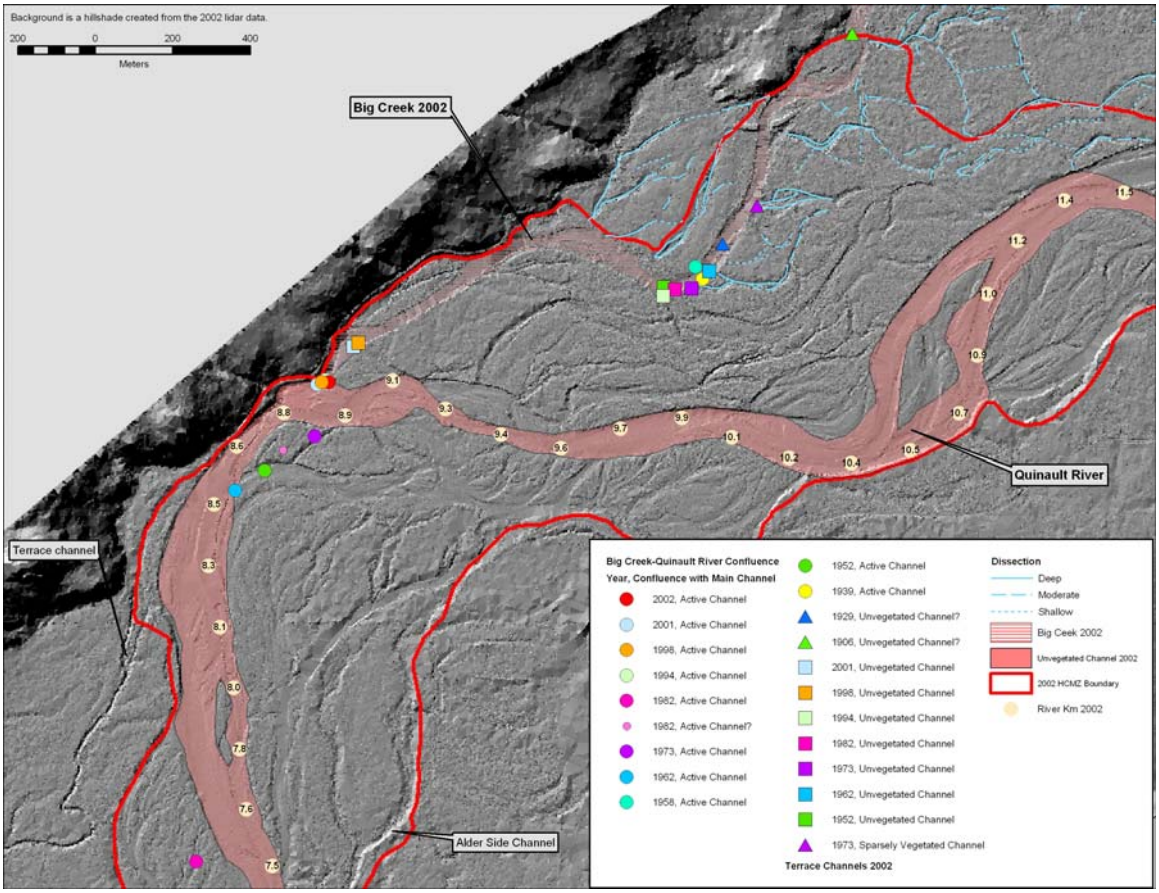


Figure 2. The positions of the intersections of Big Creek with the active and unvegetated channels of the Quinault River have varied between 1906 and 2002. However, the minimum lengths of potential habitat in lower Big Creek were relatively constant between 1906 and 1994, but markedly increased by 1998 (fig. 3). The maximum length of potential habitat was greatest in 1982.

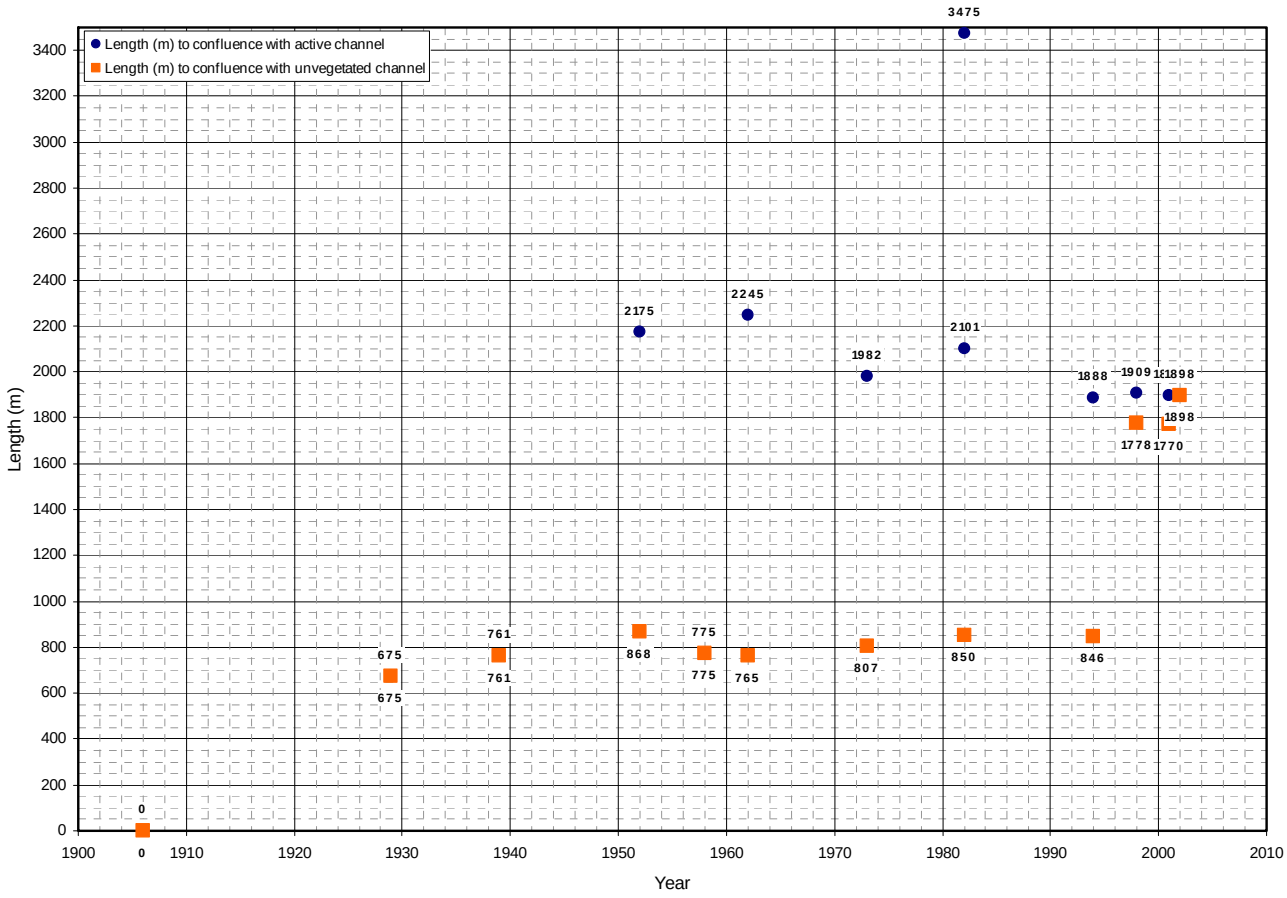


Figure 3. The minimum lengths (orange squares) and maximum lengths (blue circles) of potential habitat in lower Big Creek have varied since 1906.

The minimum lengths of potential habitat in lower Big Creek have been between 40 and 45 percent of the longest minimum length of potential habitat in lower Big Creek, which occurred in 2002.

Between 1929 and 1994, the minimum length of potential habitat in lower Big Creek was between 35 and 45 percent of the minimum length in 2002 (fig. 4). However, by 1998, the minimum length of potential habitat in lower Big Creek had increased to 94 percent of its 2002 value. This history suggests that a relatively long period of stability was followed by a relatively rapid increase in the length of potential habitat in lower Big Creek. The reason for this change is unclear, but appears to be related to the abandonment of an unvegetated channel path of the Quinault River. The change preceded a shift in the winter of 2002-2003 of the Quinault River channel to the south, away from lower Big Creek.

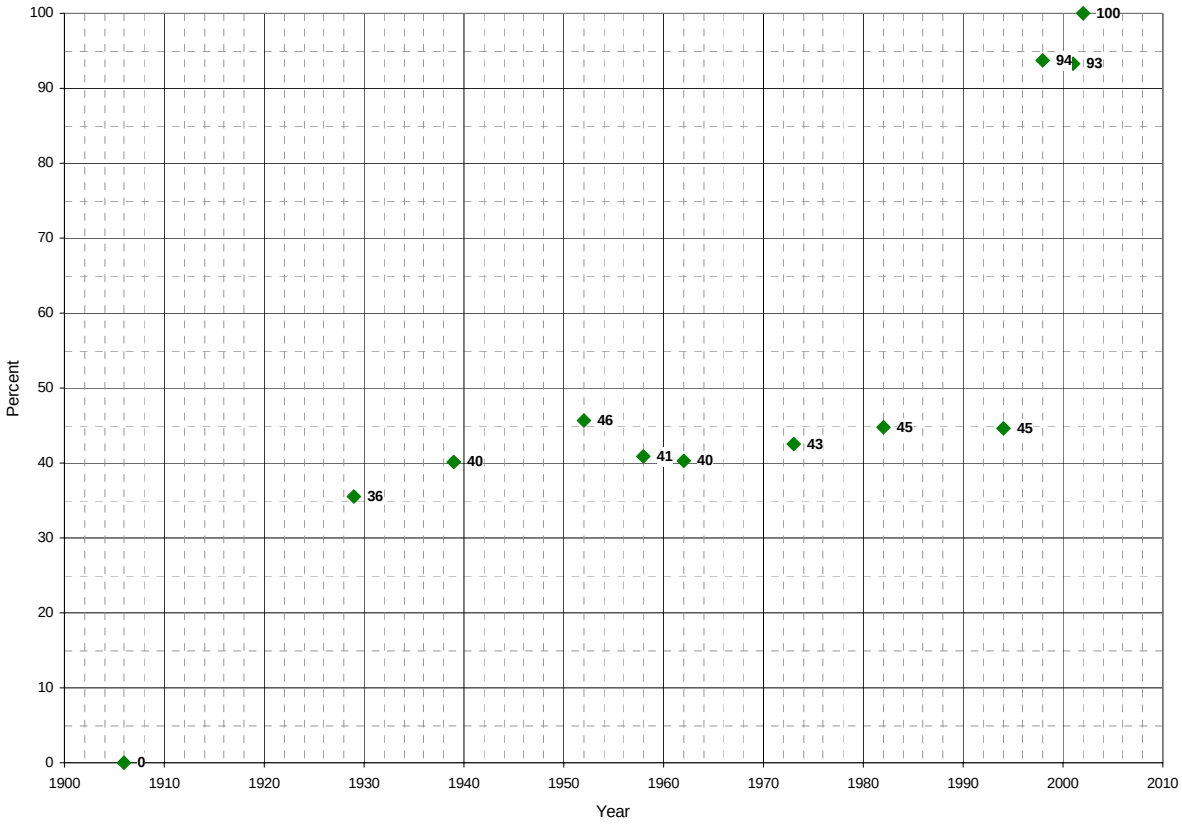


Figure 4. Minimum lengths of potential habitat in lower Big Creek over time as a percent of the minimum length of lower Big Creek in 2002 were relatively stable between 1929 and 1994, but markedly increased by 1998, after an unvegetated channel path was abandoned by the Quinault River and started to fill with vegetation.

Terrace Channels

Terrace channels are common on the Intermediate Surface between the Quinault River near RK 13.0 and lower Big Creek (fig. 5). The channels are often located along the boundary between terrace levels within our map units.

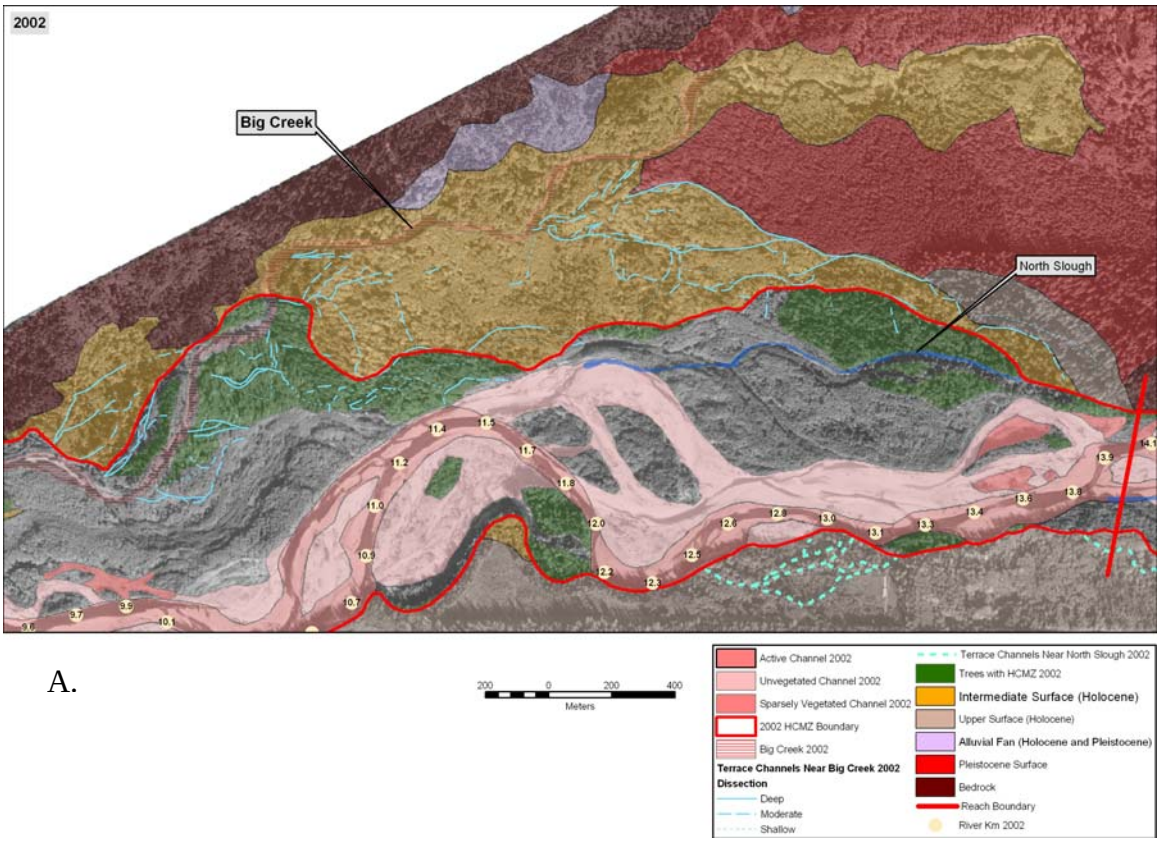
The upstream ends of the terrace channels (near the Quinault River) are not visible along the edge of the Intermediate Surface, which is 1 to 2 m above the active channel of the Quinault River, and the channels are barely visible on the surface itself. At their upstream ends, the channels are broad, poorly defined, and only a few centimeters deep. The depth and width of the terrace channels progressively increase downstream (toward Big Creek). The channels become well defined. Maximum depths of the channels closer to Big Creek are up to 2.5 m, but are commonly 1.5 to 2 m. Maximum widths are up to about 80 m, but are mostly $\leq$10 m. The channels are incised into silt and sand (floodplain deposits). The downstream portions of the terrace channels are often incised into the underlying gravel (channel deposits) (fig. 6). The gravel deposits include boulders, some with maximum diameters of 35 cm or larger. The gravel in some scour holes has been

moved as bed load at higher flows. At low flows, the terrace channels are mostly dry or have standing water only. Some channels have continuous flow, which is provided by a surface connection to the Quinault River or by groundwater.

The terrace channels appear to form by flow over the Intermediate Surface. The flow is spread out over the surface initially. But, within a few tens of meters of the terrace edge, the flow consolidates enough to incise into the fine-grained floodplain deposits that underlie the surface. Incision and lateral erosion increase downstream as flow continues to consolidate, and well-defined channels are formed. Terraces within the channels suggest intermittent periods of channel incision and widening. Incision seems to continue to the top of the underlying gravel deposits, and at this point the rate of incision probably slows. At times, the flows are enough to transport some of the gravel short distances as bed load. However, the flows in the terrace channels appear to transport mainly sand and silt. Once the channels have formed, they continue to be conduits of transport, and may move upstream by headward erosion.

Side or Overflow Channels Within the HCMZ

Channels that have only limited flow are present within the HCMZ in the Big Creek area between about RK 11.4 and RK 10.0. In some cases, these channels were once active or unvegetated channels of the Quinault River that have been abandoned, but still receive some surface flow or groundwater flow. The characteristics of these channels are similar to those of the terrace channels, although their location and origin are different. These channels also are areas of sockeye habitat.



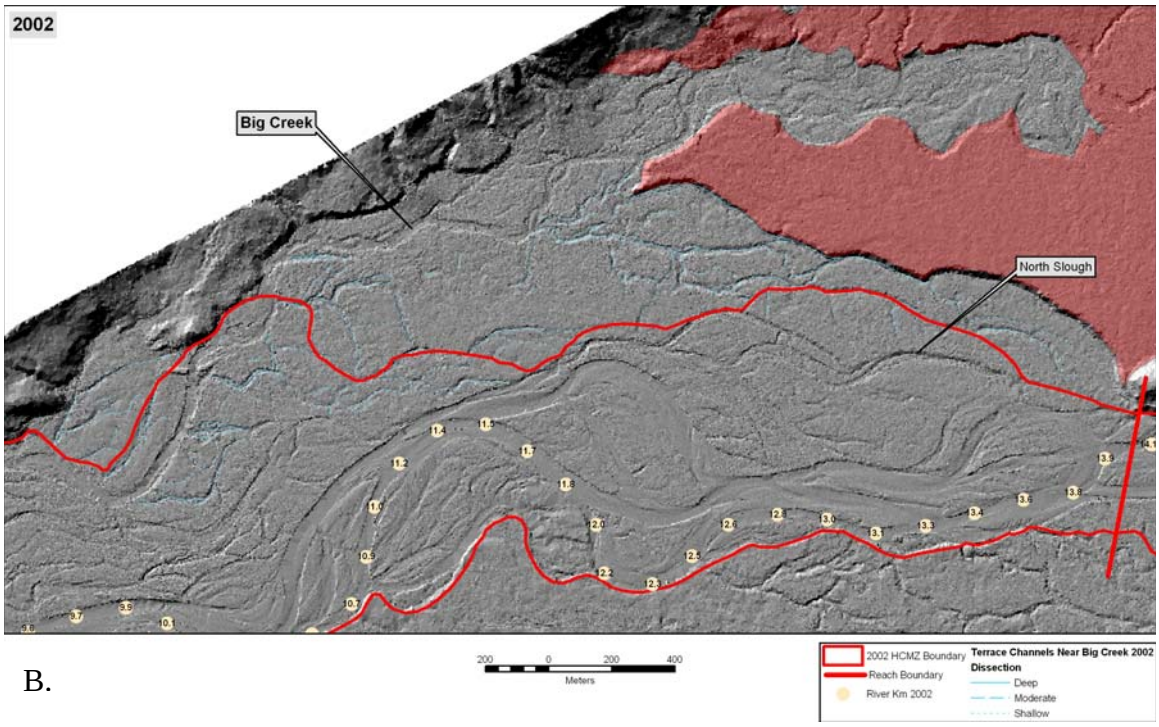


Figure 5. Terrace channels between Big Creek and the Quinault River shown on the 2002 aerial photograph (A) and a hillshade created from the 2002 LiDAR data (B).

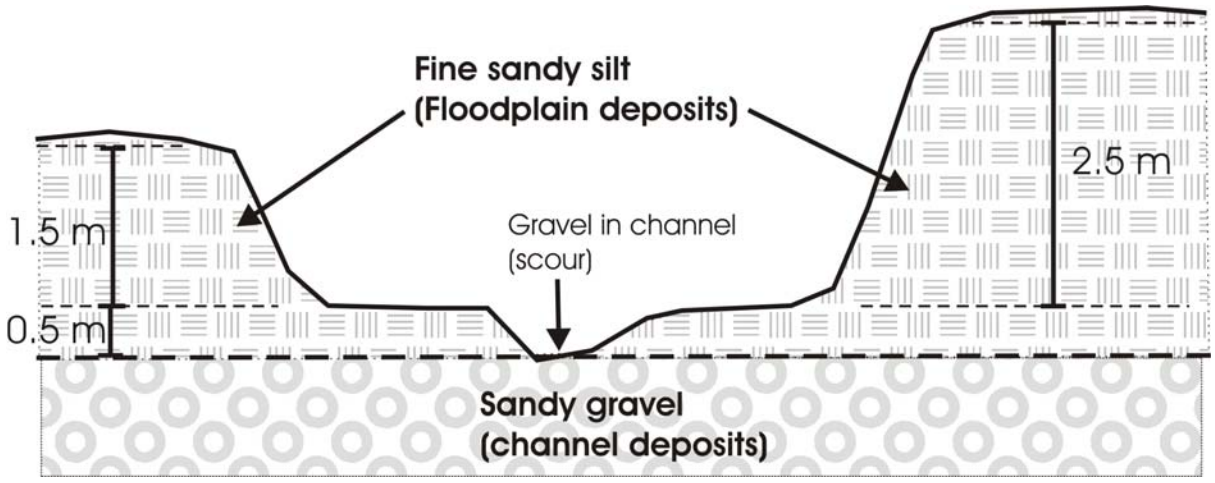


Figure 6. Schematic cross section across a well-defined terrace channel between the Quinault River and Big Creek in the Big Creek area. Dense alder with some larger cottonwood or sitka spruce occur on some of the surfaces adjacent to the terrace channels. Other surfaces are covered by ferns, sitka spruce, and big-leaf maple. The terrace channels, if vegetated, have small alder and grasses (mostly).

The following maps (Figures 7 through 16) show the history of formation and destruction of potential habitat in the area of Big Creek between 1906 and 2002. Both the lower section of Big Creek and the terrace channels between Big Creek and the Quinault River are primary sockeye habitat in the Big Creek area. Figure 17 shows the erosion of the CMZ boundary since 1939 in the Big Creek area.

Changes in the Big Creek Area by Year

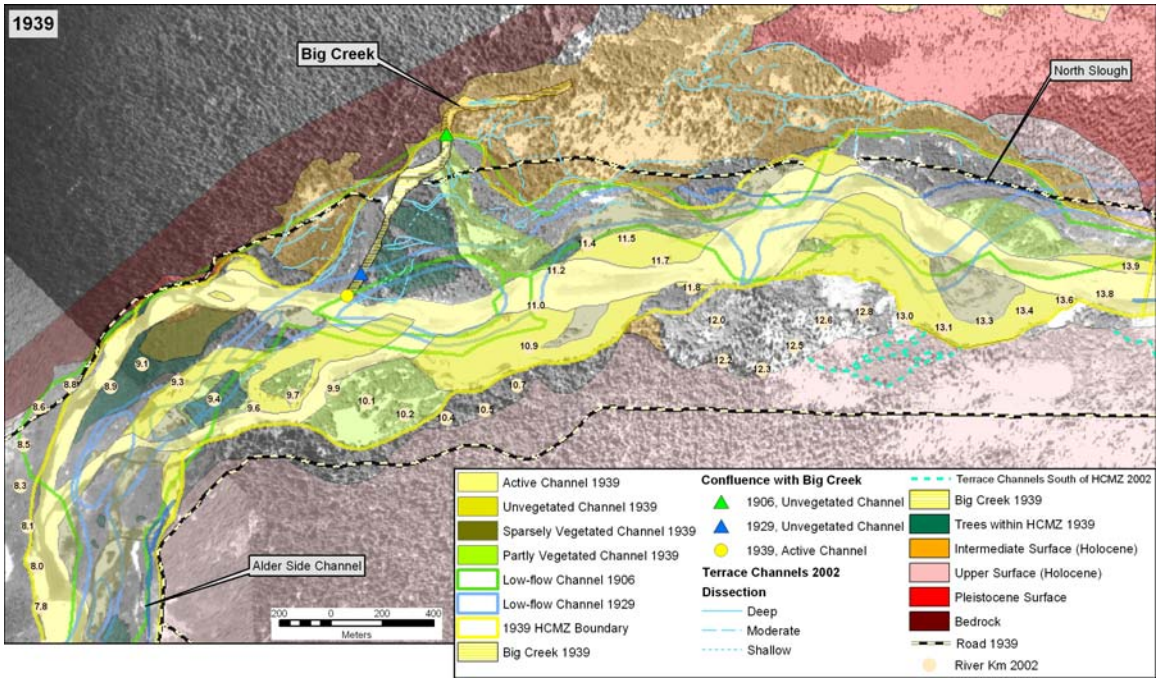


Figure 7. In 1906 (green outline), the Quinault River channel meandered to the north and included what became lower Big Creek. The intersection of Big Creek and the estimated unvegetated channel of the Quinault River occurred near the HCMZ boundary (shown by the green triangle). The 1906 channel was still visible on the 1939 aerial photographs as a band of low vegetation. The 1906 channel becomes progressively more vegetated through 2002.

By 1929 (blue outline), the Quinault River channel had moved to the south, closer to the center of the 1939 CMZ. The 1906 channel in the Big Creek area has been abandoned for at least most flows. The intersection of lower Big Creek and the estimated unvegetated channel of the Quinault River had moved downstream, increasing the minimum length of potential habitat in lower Big Creek by about 675 m.

In 1939, the confluence of Big Creek with the active channel of the Quinault River was near RK 9.9 (yellow circle), about 100 m downstream of the 1929 confluence and about 700 m downstream of the 1906 confluence. The minimum length of potential habitat in lower Big Creek in 1939 (760 m) was slightly greater than it was in 1929 (675 m). In 1939, the Intermediate Surface has been logged in the area where the terrace channels are present in 2002.

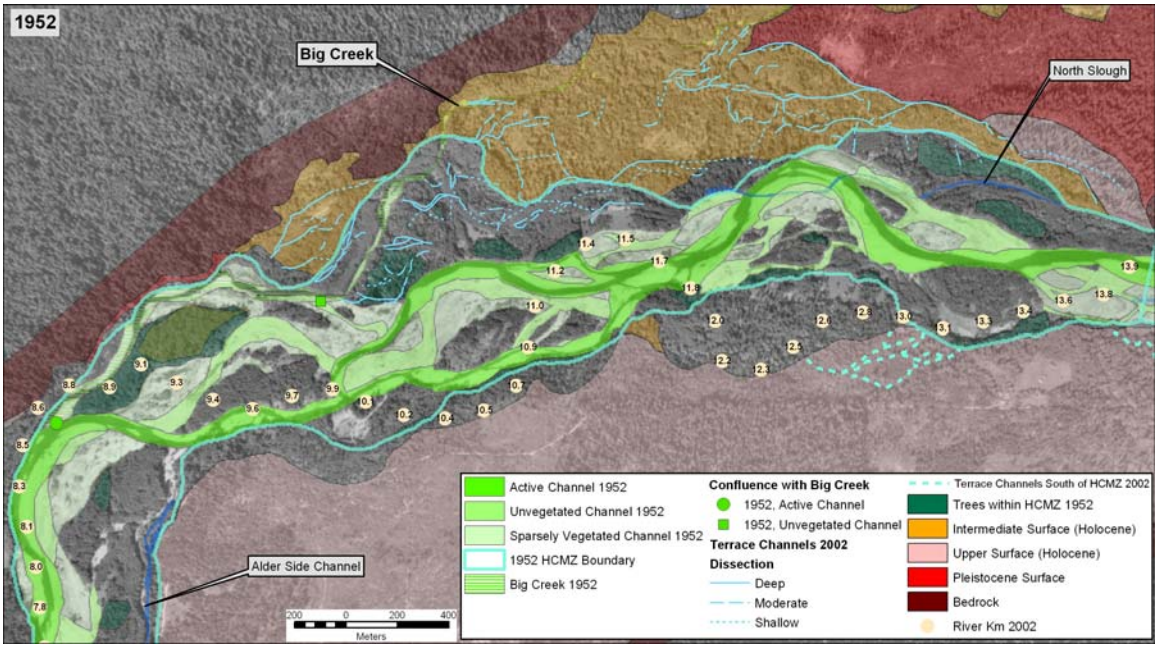


Figure 8. In 1952, the confluence of Big Creek and the active channel of the Quinault River was near RK 8.5 (green circle), and was about 1400 m downstream of its location in 1939 (fig. 2). Consequently, the maximum length of potential habitat in lower Big Creek (2175 m) was markedly longer than it was in the previous years of available record (1906, 1929, 1939). The influence of the higher flows on the potential habitat is not known. However, the minimum length of potential habitat in lower Big Creek was, at about 870 m, about the same as it was in 1939, when it was about 760 m long (figs. 2 and 3).

The Quinault River channel between RK 8.5 and RK 13.5 was braided in 1952, even at lower flows. The lower section of lower Big Creek coincided with one of at least three high-flow channels of the Quinault River in this area.

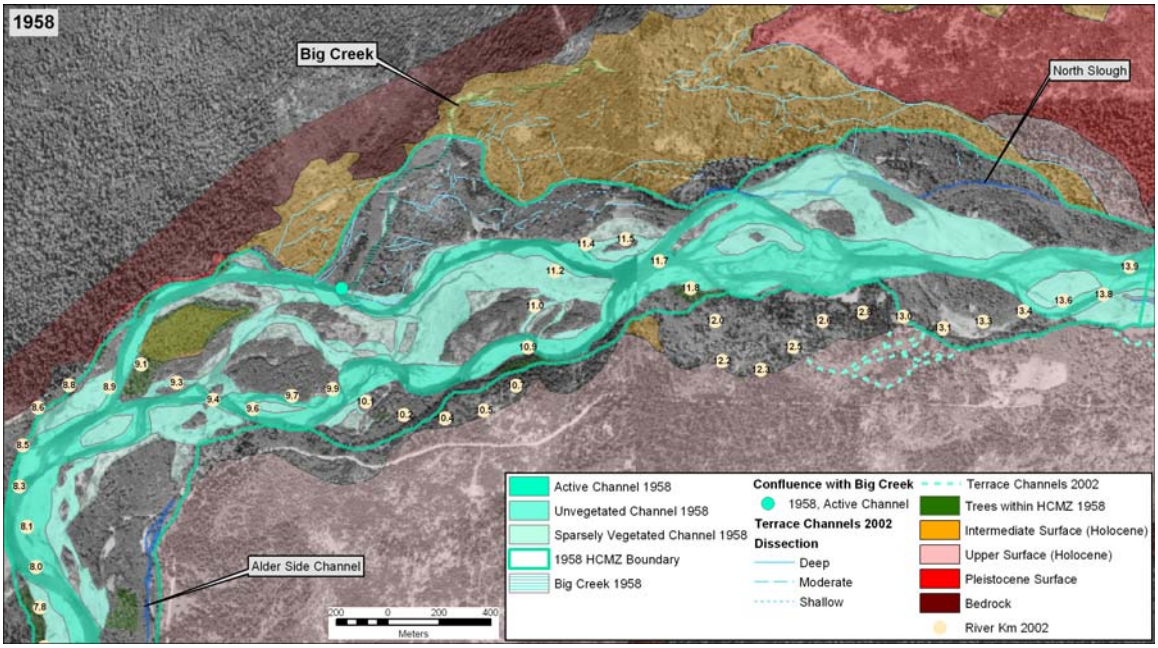


Figure 9. By 1958, the confluence between Big Creek and the active channel of the Quinault River had move upstream about 1400 m of its location in 1952. In 1958, the active channel of the Quinault River was in the 1952 lower Big Creek channel. Thus, the maximum length of potential habitat in lower Big Creek decreased to about 775 m in 1958 from 2175 m in 1952. However because lower Big Creek intersected the active and unvegetated channels near the same location, the minimum length of potential habitat in lower Big Creek in 1958 (775 m) was about the same as it was in previous years (870 m in 1952, 760 m in 1939, 675 m in 1929).

The Quinault River channel was braided, even at lower flows.

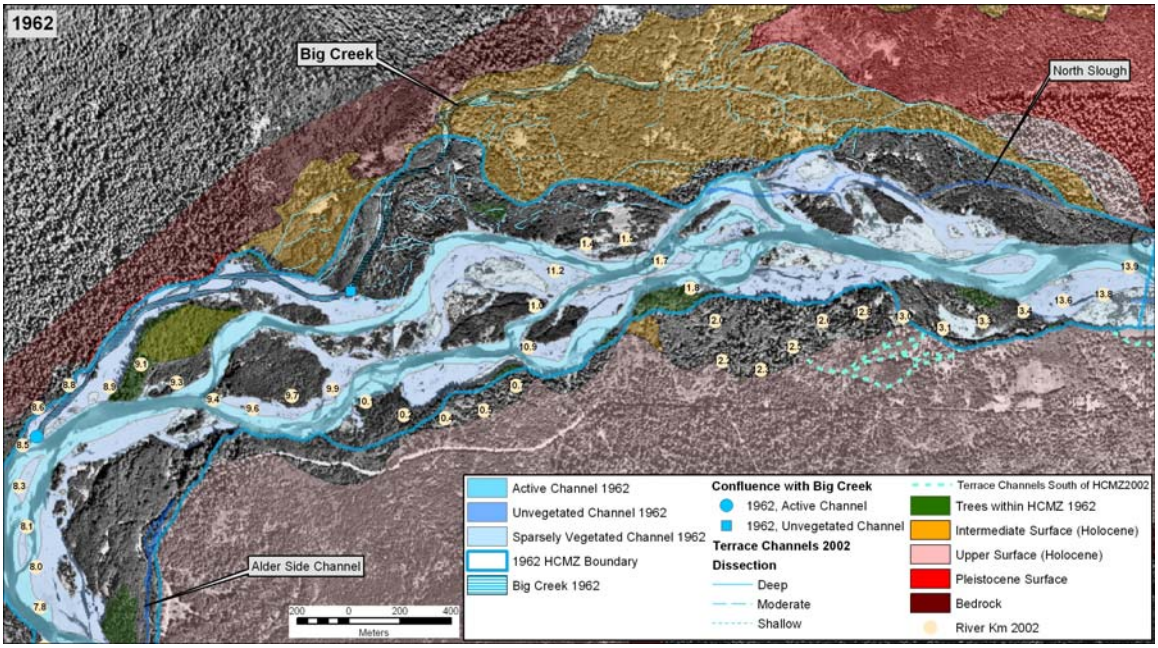


Figure 10. By 1962, the confluence between Big Creek and the active channel of the Quinault River was near RK 8.5, nearly in the same location as it was in 1952. Thus, the maximum length of potential habitat in lower Big Creek increased to about 2245 m from its maximum length of about 775 m in 1958. The minimum length of potential habitat in lower Big Creek was about 807 m, about the same as it had been in previous years (figs. 2 and 3).

The Quinault River channel was braided, and had two or more flow paths, especially at higher flows, along most of the section between RK 8.5 and RK 13.3.

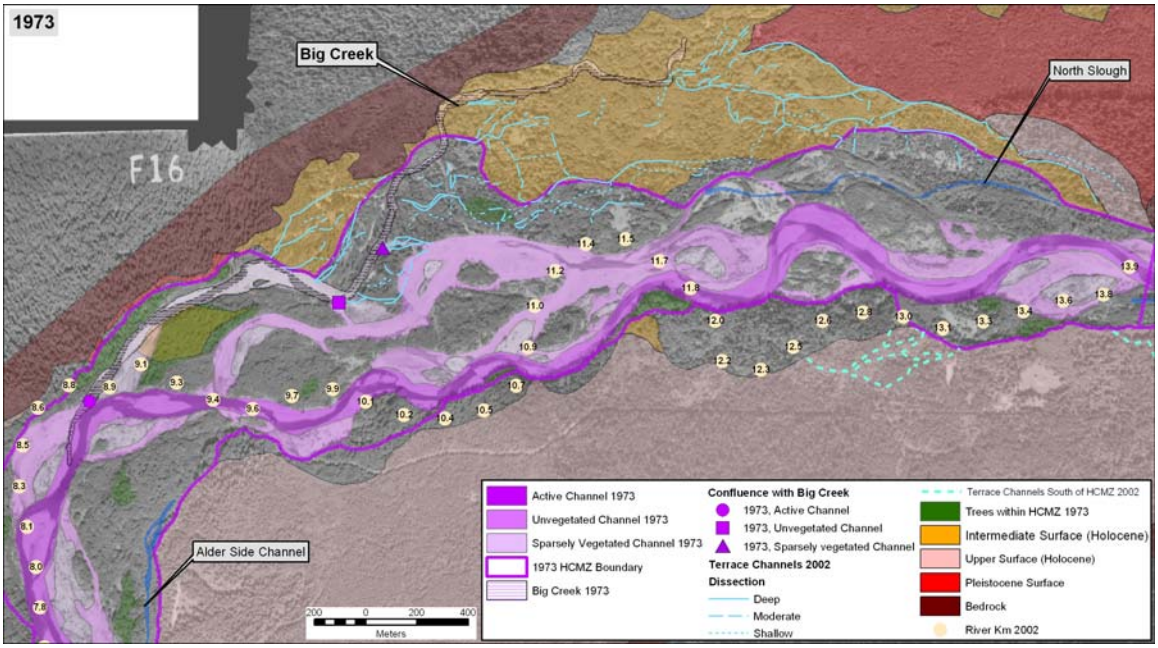


Figure 11. In 1973, the confluence of Big Creek and the active channel of the Quinault River channel was near RK 8.8, only slightly upstream of where it was in 1962. Thus, the maximum length of potential habitat in lower Big Creek was slightly less in 1973 (about 1980 m) than it was in 1962 (2245 m). The path of the active channel to the Quinault River that coincided with lower Big Creek in 1962 had become sparsely vegetated, which suggests that flows in this channel were less frequent or shallower that they were in 1962. The minimum length of potential habitat in lower Big Creek was nearly the same (807 m) as it had been in previous years (figs. 2 and 3).

The active channel of the Quinault River was primarily a single path in 1973, although the channel was braided at higher flows along this section of the river. The channel path that was active in 1906 had a small area of trees in it by 1973.

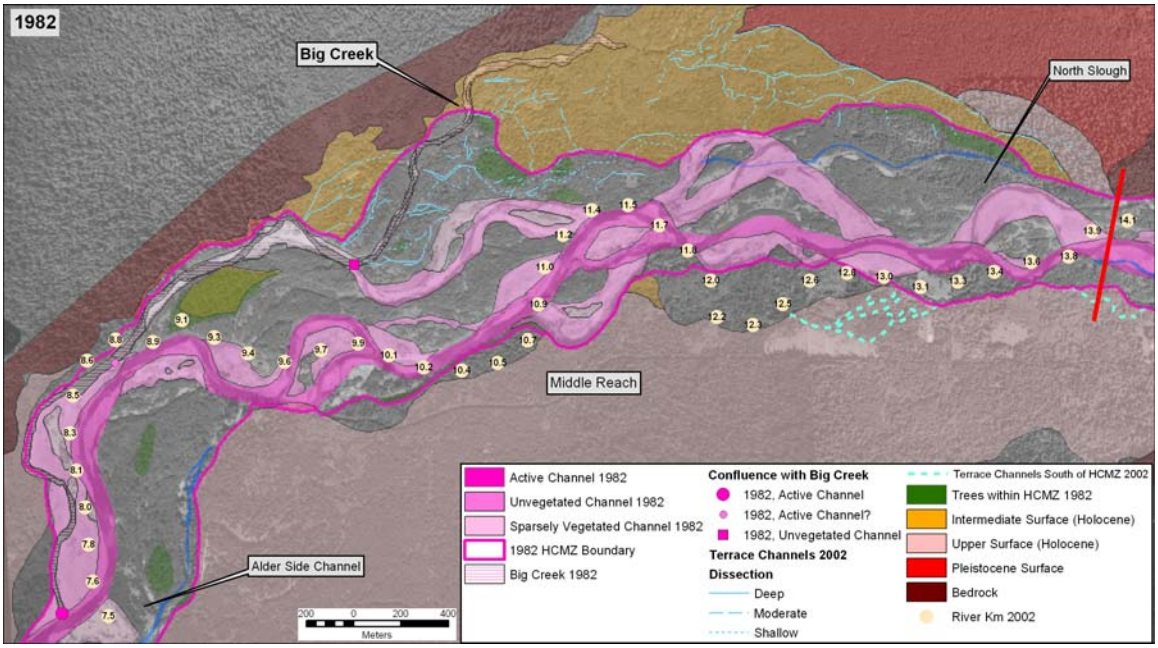


Figure 12. In 1982, the confluence of Big Creek and the active channel of the Quinault River was near RK 7.5, its farthest downstream location observable between 1906 and 2002. This made the maximum length of potential habitat in lower Big Creek about 3475 m. Lower Big Creek and the active channel of the Quinault River nearly joined near RK 8.8; however, distinct channels are observable downstream of this point. If the confluence of lower Big Creek and the Quinault River is taken to be this point, then the maximum length of potential habitat in lower Big Creek in 1982 was only about 2100 m, approximately what it was in 1952, 1962, 1973, and 1982. At higher flows a connection between lower Big Creek and the unvegetated channel of the Quinault River occurred downstream of RK 9.8. The minimum length of potential habitat in lower Big Creek was about 850 m, about the same as it had been in previous years.

The active channel of the Quinault River was mostly a single strand, although two short sections of split flow were present between RK 9.6 and RK 10 and between RK 11.2 and RK 11.7. The unvegetated channel was braided in one location only, between RK 11.7 and RK 12.8. The channel path near Big Creek that was active in 1906 had a slightly larger area of trees in 1982 than it did in 1973.

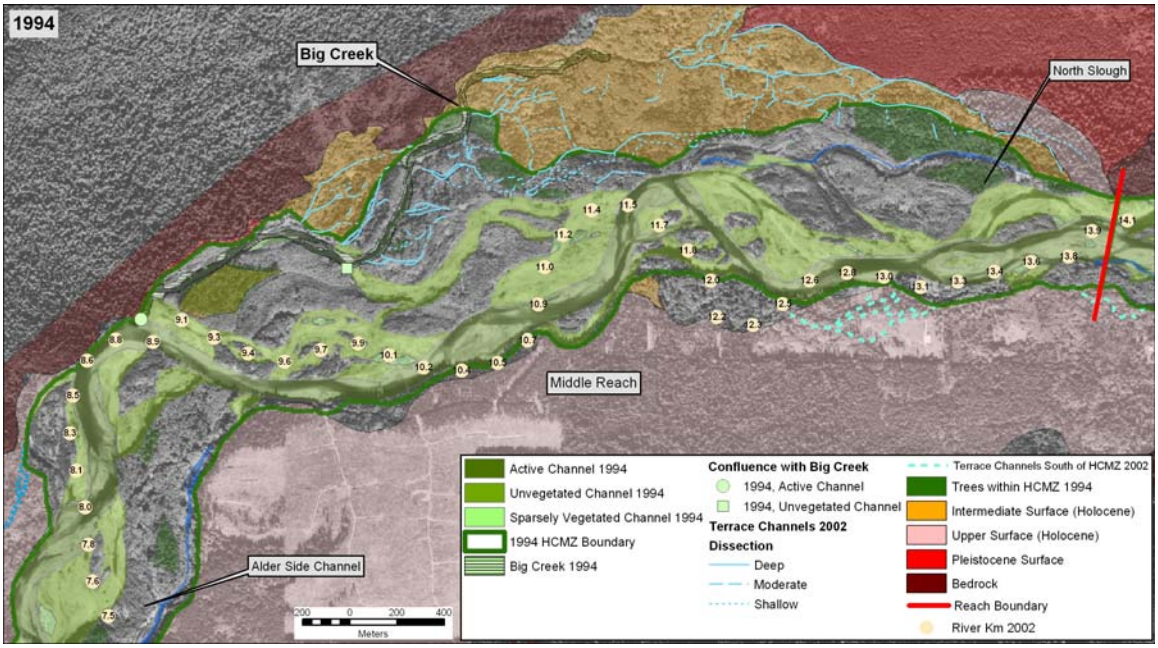


Figure 13. In 1994, the confluence between Big Creek and the active channel of the Quinault River was near RK 8.8, about where it was in 1952, 1962, and 1973. Thus, the maximum length of potential habitat in lower Big Creek was about 1890 m in 1994, about the same length that it was in the previous years listed above. Lower Big Creek coincided with the unvegetated channel of the Quinault River near RK 9.9. The minimum length of potential habitat in lower Big Creek was about 845 m, about what it had been since 1929.

The active channel of the Quinault River had a single path along this section of the valley in 1994. The unvegetated was wide and slightly braided. The channel path that was active in 1906 in the lower Big Creek area had a larger area of trees in 1994 than it did in 1982.

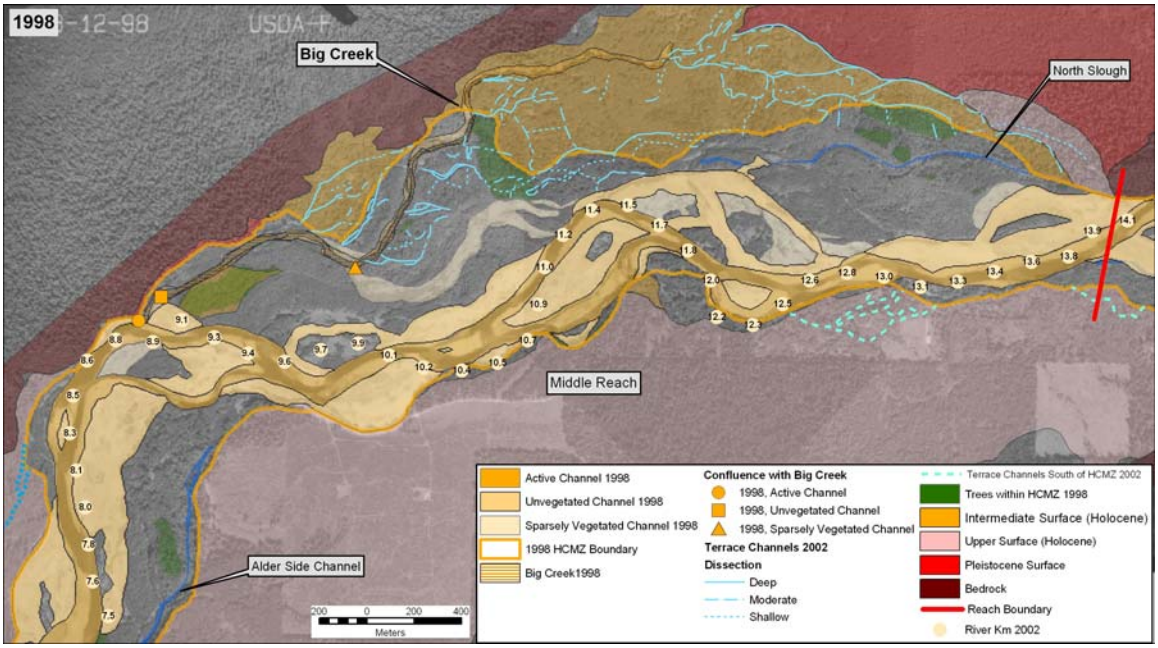


Figure 14. In 1998, the confluence between lower Big Creek and the active channel of the Quinault River was in about the same location as it was in 1994, so that the maximum length of potential habitat in lower Big Creek was about 1910 m. However, the confluence between lower Big Creek and the unvegetated channel of the Quinault River had moved downstream since 1994. Thus, the minimum length of potential habitat in lower Big Creek upstream of this confluence had increased to about 1780 m. (It was only about 845 m long in 1994.) The unvegetated channel that coincided with lower Big Creek in 1994 was sparsely vegetated by 1998, and may or may not have carried flow from the Quinault River in 1998.

The active channel of the Quinault River was primarily a single path along this section of the valley. The unvegetated channel had multiple paths mainly between RK 11.5 and RK 12.8.

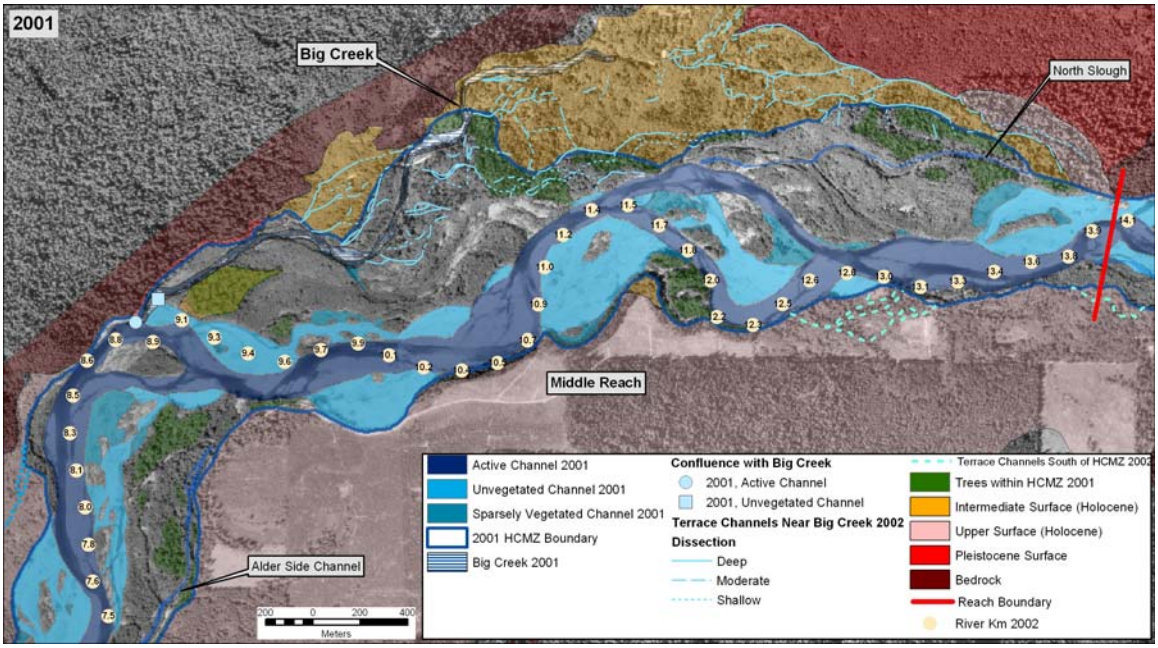


Figure 15. In 2001, the confluences between Big Creek and both the active channel and unvegetated channel of the Quinault River were near their locations in 1998. Consequently, the maximum and minimum lengths of potential habitat in lower Big Creek were about the same as they were in 1998 (figs. 2, 3, and 4). The path of the unvegetated channel of the Quinault River that had connected to lower Big Creek between 1962 and 1994 contained more vegetation than it did in 1998.

The active channel of the Quinault River was a single path, except between RK 11.5 and RK 12.7, where the channel had two paths of similar size. The unvegetated channel was wide, and had multiple paths primarily in this area.

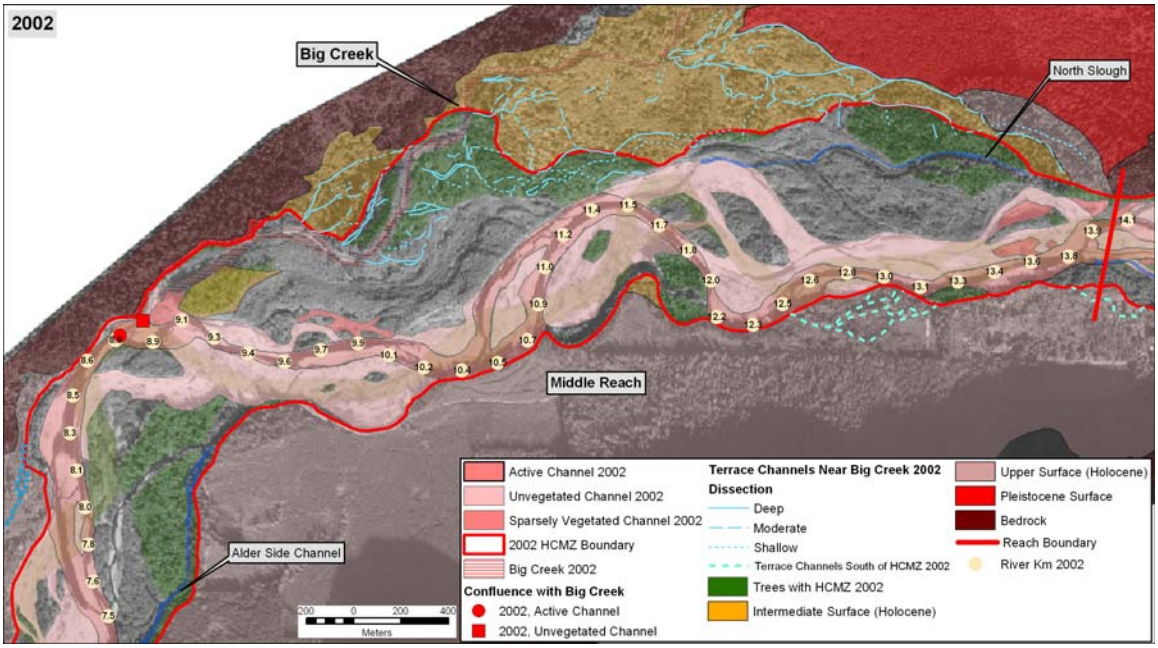


Figure 16. By 2002, the confluence of Big Creek with the active channel of the Quinault River was near RK 8.9, in about the same location as it had been since 1994. In 2002, lower Big Creek intersected the active channel and unvegetated channel in the same location, making the minimum length of potential habitat in lower Big Creek the longest it had been since 1929 (figs. 2, 3, and 4). The unvegetated channel path that was present between 1962 and 1994 had more vegetation than it did in 2001, although flow path was still visible.

The active channel of the Quinault River was a single path, except between RK 10.5 and RK 11.2, downstream of the section with multiple paths in 2001. The unvegetated channel was wide, and had multiple paths between RK 11.5 and RK 12.6. The channel path that was active in 1906 in the lower Big Creek area and that had become progressively more vegetated since 1973, included a large area of trees by 2002.

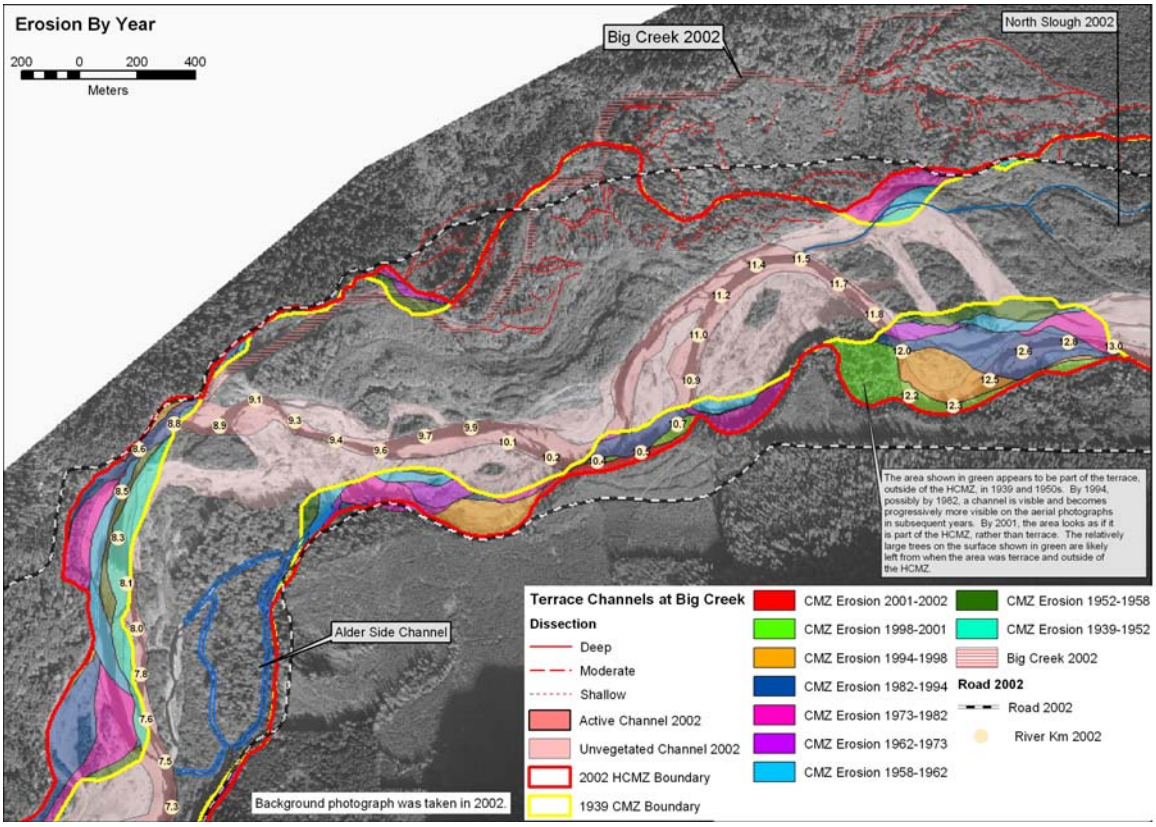


Figure 17. Bank erosion between 1939 and 2002 along the south boundary of the HCMZ allowed the north boundary to be relatively stable in the Big Creek area. The north boundary has remained relatively unchanged since 1939, except near RK 12. Consequently, vegetation has become progressively denser and larger on the north side of the HCMZ in the Big Creek area. The stability on the north side allowed the terrace channels to form, and resulted in a relatively constant minimum length for lower Big Creek, the section of lower Big Creek upstream of its intersection with the unvegetated channel of the Quinault River. The maximum length of lower Big Creek has been highly variable since 1929, in part because erosion of the west (or north) HCMZ boundary downstream of RK 8.8 allowed the maximum length of lower Big Creek to increase between 1929 and 1982. After that time, a shift in the position of the Quinault River channel resulted in a decrease in the maximum length of lower Big Creek, to a value less than the maximum length between 1952 and 1973.